MANAGEMENT FOR COMMERCIAL TIMBER

CLARK FORK UNIT, MONTANA

INTERMOUNTAIN FOREST & RANGE
EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE
OGDEN, UTAH
REED W. BAILEY, DIRECTOR

RESEARCH PAPER 65

1962

The Authors

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHERN REGION

FEDERAL BUILDING
MISSOULA, MONTANA

ADDRESS REPLY TO
REGIONAL FORESTER
AND REFER TO
1630 (1000)

Dear Sir:

A Regional Forester doesn't ordinarily send a letter along with an Experiment Station publication. However, this is a special report and the study behind it was made at the request of my predecessor, Charles Tebbe.

The management of commercial forest land of the Northern Region, both public and private, is a difficult job. We have made great progress in protecting this forest, making it accessible, and administering it. However, the art and practice of tree growing has not advanced as rapidly or as far.

This situation, as you may know, has been of great concern to public and private foresters alike. We asked for this study to get a better understanding of the nature and extent of present deficiencies in forest silviculture. My purpose in writing this letter is twofold: first, to publicly commend the authors for a factual, straightforward discussion of the subject; second, to urge you to take time to read the report. If we can get public understanding of this problem, we will be able to move more rapidly toward building up the truly large timber productivity of the National Forests in this Region.

Sincerely yours,

Boyd L. Rasmussen

BOYD L. RASMUSSEN
Regional Forester

Enclosure

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S. BLAIR HUTCHISON
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Cover picture by Marge Dodge

FIG. 1

The Clark Fork Unit includes all of the Clark Fork River Drainage west of the Continental Divide in Montana. Flathead and Lincoln Counties are the only two western counties not included. The total area in the unit is 10.4 million acres. About three-quarters of that area, or 7.6 million acres, is forested, of which 6.5 million acres are suitable for commercial timber production. This commercial area annually produces about 600 million board feet of logs which, when converted to timber products, are worth approximately $50 million.

INTRODUCTION

Up to now, the inadequacy of forestry financing has made it necessary to assign low priority to silviculture such as planting and thinning in the Mountain States. In relation to the total job, little of this work has been done. In the past few years, however, a growing public sense of urgency about resource management has brought the silvicultural issues to the forefront. More than ever before we are looking beyond present values in the forests to the contributions that should be expected from them in the long run.

For years conservationists have been preaching this doctrine of providing adequately for the future. Now it is getting serious consideration in the public mind and we are able to consider the plans and finances necessary to achieve long-range resource goals.

In the study reported in the following pages we have attempted to appraise the timber management job involved in increasing production on a fairly representative area of the U.S. Forest Service's Northern Region.[1] The area involved is the 10.4-million-acre Clark Fork Unit described in figure 1. It will, of course, be a long time before all the silvicultural and economic questions relating to the details of management of the Clark Fork Unit will be solved. However, it is necessary at this stage to bring the problems and potentials of the area into focus and to describe the broad programs required to cash in on the opportunities the timber presents.

* * * *

Timber has furnished a substantial annual income to the Clark Fork Unit for more than half a century and can continue to do so in the future. This fact is evident even to the casual observer who sees only the general forest landscape. The forest, which occupies a big part of the total area, is green and obviously is producing a lot of wood.

Not so evident is the amount of effort that will be required to achieve specific levels of timber growth in years to come. Although the prevailing public mood seems to be one of implicit faith that the forest will provide, a close examination of the situation indicates that unless this faith is supported with some good works, timber yields in the future will fall far short of what the land can produce and what the Nation is expected to need from this area. No one really knows how much effort will be required to get the forest land of the Clark Fork to provide in adequate amounts. The Forest Service has set a production goal for the national forests of its Northern Region of 2.4 billion board feet (International ¼-inch rule) by the year 2000. This amounts to a big jump from the 1959 cut of 1.1 billion board feet. Nevertheless, only a start has been made in the complex task of judging the characteristics and capacities of hundreds of thousands of individual stands and determining the nature and cost of the silviculture required to produce a desirable sequence of yields from these stands.

The task of developing a program to increase forest production in this area is complex not only because of the number of stands involved but also because some very stubborn problems must be solved in managing the growing stock nature has provided. Timberland in this part of the United States has a much higher productive capacity than most foresters realize, but on the other hand, the natural unmanaged forest, on the whole, is a

[1]Montana, Idaho north of the Salmon River, and the three northeastern counties in Washington.

surprisingly inefficient timber producing unit. **UNLESS SUBSTANTIAL EFFORT IS PUT INTO CULTURAL WORK, FUTURE TIMBER YIELDS ARE LIKELY TO BE DISAPPOINTINGLY SMALL AND OF DISAPPOINTINGLY LOW QUALITY.** Disappointments will be greatest in terms of larger premium-quality trees, but even for fibre the productivity of "natural" stands leaves a great deal to be desired.

* * * *

Considering that few people knew the meaning of the word "forestry" 50 years ago, land managers have made enormous progress. Nevertheless, there has been considerable uncertainty in the past half century as to where this region fits into the total forestry picture. That being the case, it has been hard to focus efforts.

Fortunately, the haze has lifted somewhat in recent years. We are now beginning to get a clearer picture of what future goals should be. In this analysis, we have taken a new look at the forestry job. Specifically, this report considers what a mounting need for wood, the qualities of the local species, and the economics of management seem to point to in the way of a forestry program for the Clark Fork Unit.

Many persons have helped provide the data used in this analysis and have reviewed the statements herein. Special thanks are due G. M. DeJarnette and Henry C. Jacobs, Division of Timber Management, U.S. Forest Service, Missoula, Montana, for assistance in estimating forestry costs.

THE MANAGEMENT PROBLEM

In 1958 about 600 million board feet of sawtimber were logged in the Clark Fork Unit. As in the rest of the Northern Rocky Mountain Region, that level of cut is below the potential capacity of the forests to produce wood. For example, the Forest Service has set its sights on raising the sawtimber output of the Clark Fork Unit national forests from 202 million board feet in 1960 to something like 620 million board feet in the year 2000.[2] There is reason to believe that such a rapid buildup of cut cannot be achieved without seriously depleting growing stock because much of the present growing stock is not all it should be. Nevertheless, 620 million board feet is certainly a reasonable longe-range goal considering the capacity of the land to produce wood. We estimate that it should eventually be physically feasible to sustain an annual sawtimber cut of 1.1 billion board feet from the lands of all owners in the unit. This is about twice the present cut.

The fact that 620 million board feet can be produced annually on the national forests, and 1.1 billion board feet on all lands, should not, however, be regarded as a promise of what will happen. The forest of the Clark Fork Unit now produces far less than this, and there is no certainty these yields will be achieved. We realize this statement is contrary to the impression one gets from traveling through the forest and from watching

[2]Actually, the Forest Service has as yet only established a production goal for the region as a whole. The objective for the Northern Region is 2.4 billion board feet (International ¼-inch rule). The above estimate for the Clark Fork Unit was derived from this figure on the assumption that about 26 percent of the production capacity of Northern Region national forests is in the Unit.

truckloads and trainloads of logs pouring out of the hills. However, the procession of logging vehicles has been tapping timber reserves built up by nature over many decades. This facade of abundance masks a timber growing situation that is not satisfactory.

WHEN ALL THE PLUSES AND MINUSES OF TIMBER RESERVES AND GROWING STOCK CONDITIONS ARE ADDED TOGETHER, THE COMMERCIAL FOREST OF THE CLARK FORK UNIT CURRENTLY APPEARS TO BE JUST ABOUT ONE-THIRD AS PRODUCTIVE AS IT SHOULD BE. In other words, the current effective productivity of the 6.5 million acres of commercial forest in the Clark Fork Unit is just about what could be achieved by 2 to 2.5 million acres stocked with high vigor trees and managed intensively (fig. 2).

However, that is only one side of the coin. It is equally important to appreciate how much the productivity of this forest can be increased by thinning and other forestry practices. Of course, the forest cannot be transformed overnight because the land manager will have to work with some low vigor growing stock during the present rotation. Also, it will take time to do all the stand treatment work that is needed and more time for this treatment to produce the desired effects. Nevertheless, a well-directed silvicultural effort in the Clark Fork Unit should achieve fairly high timber production. John H. Wikstrom and Charles A. Wellner have shown that the volume and value of utilizable timber can be greatly increased by thinning and pruning (*9*).[3] We shall discuss that opportunity in more detail later in this report. It is sufficient here to raise three points in anticipation of that discussion:

- The forest as a whole is not in a highly productive condition today.
- Efforts to regenerate new stands on cutover areas are considerably less than 100 percent successful.
- The growing stock in this unit is undergoing a subtle, unnecessary, and undesirable deterioration. As a result, the timber we are growing is poorer than the timber we are cutting.

As long as these circumstances prevail, it is unlikely that a sawtimber cut much larger than the present can be sustained in the Clark Fork Unit. On the other hand, as we have already stated, the potential is there for a much larger production if the silvicultural effort is expanded (fig. 3).

THE TWO BIG PROBLEMS THAT MUST BE FACED IN TIMBER MANAGEMENT ARE THAT THERE ARE TOO MANY TREES IN MOST STANDS AND NOT ENOUGH IN SOME OF THE REST. The task ahead has been aggravated by diseases, insects, poor distribution of ages and sizes of trees, and inadequate regeneration of new stands in cutover areas.

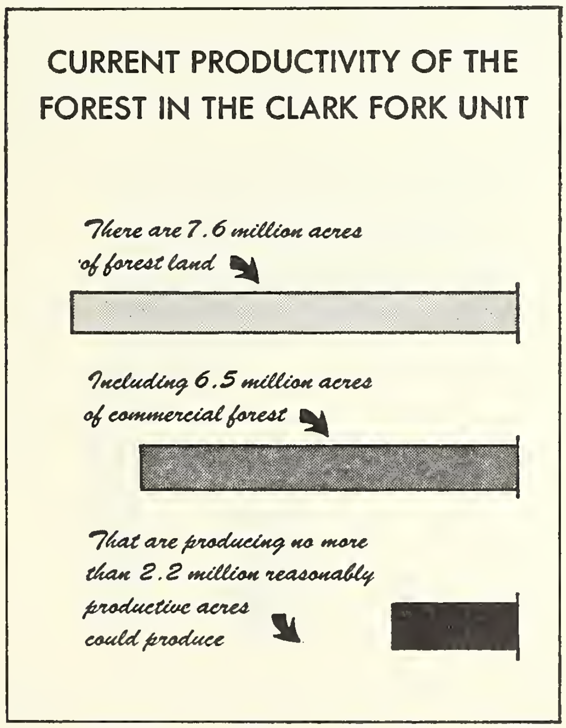


FIG. 2

Poorly stocked stands

Forest Survey records show that 15 percent of the commercial forest in the Clark Fork

[3]Italicized numbers in parentheses indicate numbered items in Literature Cited.

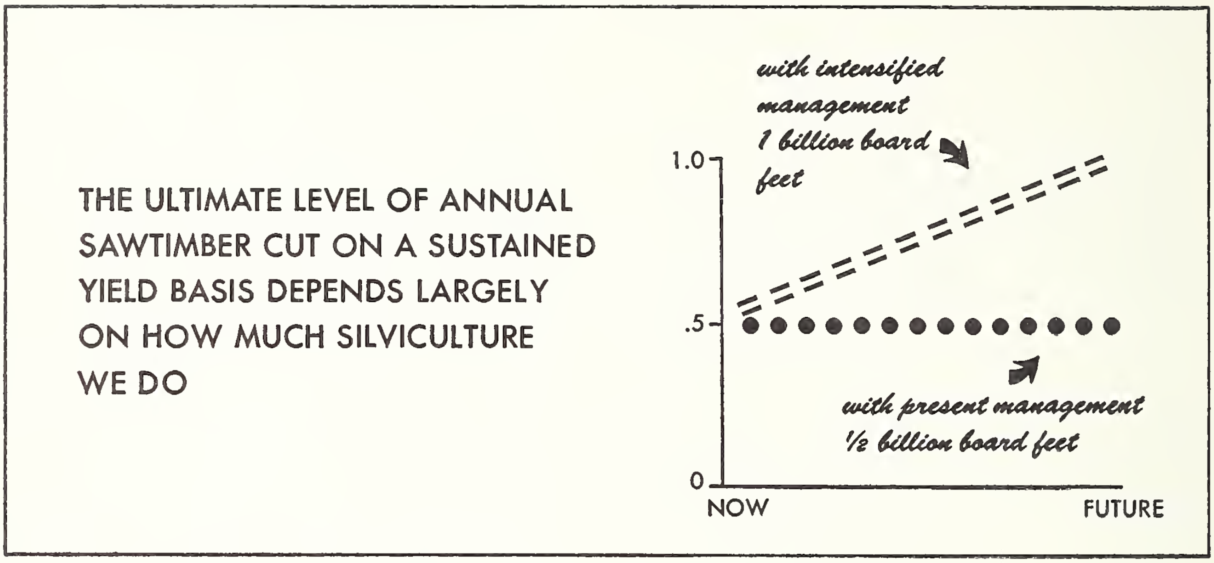


FIG. 3

Unit is understocked. This situation prevails to some extent in all types, but is particularly important in the ponderosa pine type. Ponderosa pine is characteristically an open-grown species, and on the thinner soils poor stocking may represent full use of the growing space. However, even when appropriate allowance is made for that fact, most of the present stands fall short of desirable stocking.

Figure 4 depicts the situation in national forest ponderosa pine stands. In terms of area equivalents the stand of all trees 4 inches and larger appears to be about two-thirds of what it should be for capacity production. The stand of ponderosa pine trees alone is at only one-third of the desired level. Actually, the data in this chart minimize the problem, as no distinction was made in inventory tallies avail-

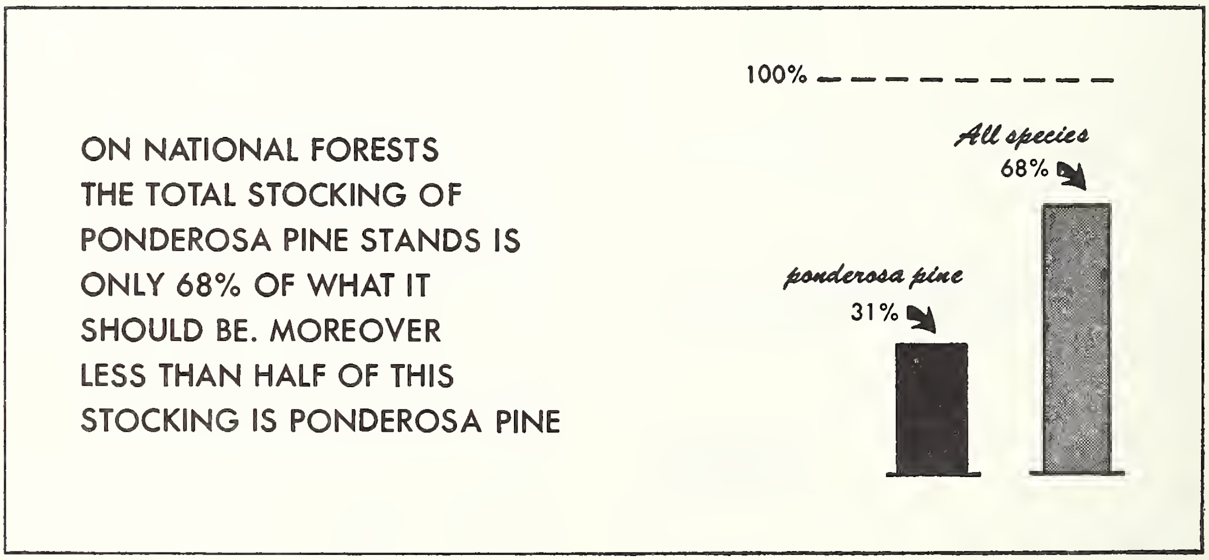


FIG 4

able to us between trees that by virtue of position and quality will be featured in management and those which from that point of view are excess. If it were possible to separate the "sheep" from the "goats," we probably would find that the ponderosa pine trees we can reasonably expect to carry through to maturity occupy even less of the growing space than indicated.

Overstocked stands

The area with not enough trees is considerably exceeded by the area with too many. Figure 5 shows the composite picture of the stand on a 132,000-acre area near St. Regis. In the critical younger years of the stands the proportion of excess or surplus trees competing for light and moisture is often large, and they are a massive drag upon the productivity of the commercial forest. Overstocking is, in fact, the most important single roadblock in the way of higher production.

The problem of too many trees is most severe in the lodgepole pine type wherein some stands have completely bogged down like the one pictured in figure 6. Facts and figures on stagnation are skimpy, but it seems likely that at least one-third of the present seedling, sapling, and pole stands in this type should be "written off" so far as future growth is concerned because they cannot recover from suppression (table 1). Some of these young stands in various stages of arrested development contain trees that may eventually be utilizable. However, at least 80,000 acres support stands worth little or nothing for timber production, and on most of the remainder of the 1.9 million acres of lodgepole pine type the yields will be low because trees have lost vigor due to overcrowding.

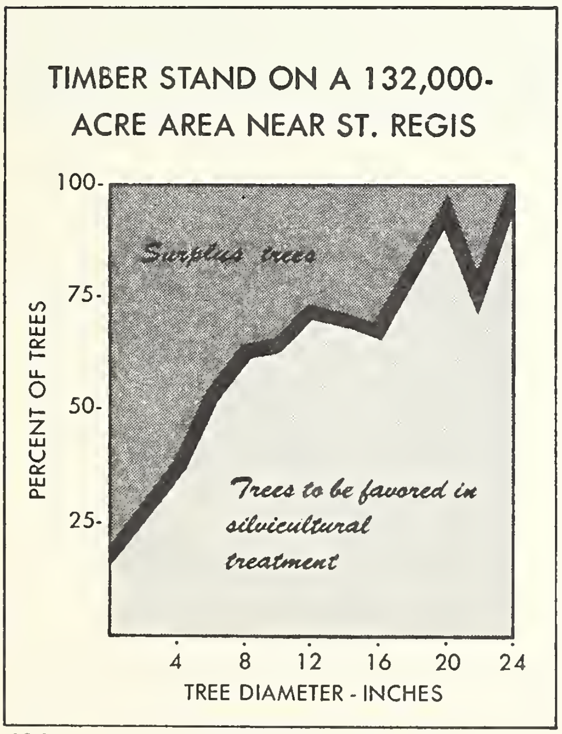


FIG 5

Table 1. — *Estimated condition of lodgepole pine seedling, sapling, and pole stands in the Clark Fork Unit*

	Acres	*Percent*
Growing stands	1,071,000	65
Stagnated stands		
Large poles[1] probably utilizable	363,000	
Small poles[1] may eventually be utilizable	132,000	35
Seedling and sapling[2] stands, no present or future value	82,000	
Total stagnated	577,000	
Total pole, seedling, and sapling area	1,648,000	100

[1]Pole stands in which the majority of the dominant trees are 7.0 to 10.9 inches d.b.h. are classed as large poles. Small poles include trees 5.0 to 6.9 inches d.b.h.

[2]This is strictly a size category. Actually, some of the stagnated seedling and sapling stands are old.

Overcrowding exerts its depressing effect upon diameter growth in other types also. For example, in the larch type, which occupies three-quarters of a million acres, the problem is but slightly less serious than in the lodgepole pine type. Relatively few acres in

A STAGNATED STAND OF LODGEPOLE PINE ABOUT 40 YEARS OLD IN THE SEELEY LAKE AREA.

CHART SHOWS THE RELATION OF DIAMETER GROWTH TO STAND DENSITY IN GOOD SITE LODGEPOLE STANDS IN THE ST. REGIS AREA.

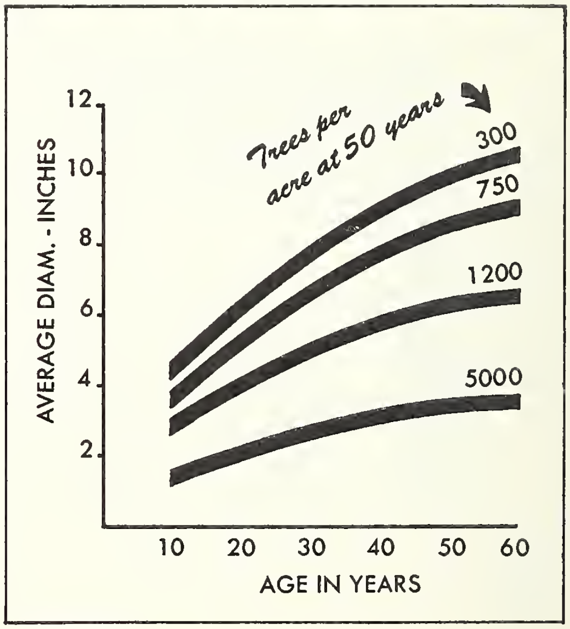


FIG. 6

this type are completely stagnated, but we estimate that in two-thirds of the young stands, overstocking will require lengthening the rotations or settling for smaller size trees. Larch has a reputation for being slow growing; yet, given room, it will grow quite rapidly. For example, it should be possible to grow crop trees averaging 19 inches in diameter in 140 years on medium sites. *In most unthinned natural stands, 200 years or more will be needed to produce crop trees of this size.*

The story in the spruce type is different only in detail. In rotation-age spruce stands of western Montana the area of stem cross sections per acre (basal area) is about what it should be. However, the volume of sawtimber in rotation-age stands is only about half the volume expected from stands stocked with uniformly distributed trees,[4] thus indicating that the trees are growing in thickets interspersed with openings and that when distribution is taken into account the basal area is divided among too many stems.

The surplus trees in some stands do not represent serious enough competition to warrant their removal. Indications are, however, that the competition of these extra trees is a critical problem in most young stands. In the previously mentioned area near St. Regis, for example, a survey of management needs shows that serious competition occurs on 7 out of 10 acres of pole size or smaller timber (fig. 7). Surprising as it may seem, it is already too late to do anything about the overcrowding on 3 of these 7 acres. Although the stands are relatively young, the trees in many of them have such short crowns they will not respond satisfactorily if released by thinning.[5]

[4]The objectives in this case are based on 75 percent of normal yield table values.

[5]Much of the seriously retarded timber is lodgepole pine, a short-lived species in the white pine country. Unless it grows rapidly during the first 40 years of its life, this lodgepole is still small at 80 to 100 years when the stands become mature and begin to decay.

For the longer lived species, the situation can be at least partially retrieved in stands not too seriously retarded. The years lost cannot be regained, but with thinning and extension of rotations, substantial timber yields are still possible. For example, as figure 8 shows, larch can come back after being suppressed, and ponderosa pine likewise responds to release. However, while trees of the longer lived species can respond to release at older ages, they do not respond significantly unless freed of competition while they still retain good crowns and vigor.

The fine sawtimber trees and stands that have been and are supplying industrial needs probably grew under such conditions of overstocking as we have described here. However, as indicated earlier, it took considerably longer than 120 or 140 years to grow most of the logs being cut today. Moreover, for every acre that produced merchantable sawlogs, some fraction of an acre spent a whole rotation producing little or nothing.

Mistletoe damage

Destructive agents have played havoc with the productivity of many acres. The part that fire and insects have had in timber losses has been sufficiently well documented that there is no need to discuss it here. On the other hand, the damage by dwarfmistletoe is less well known. This relatively inconspicuous plant parasite is no newcomer to the forest. A quarter of a century ago Boyce pointed out that "Dwarfmistletoes cause extensive damage in western coniferous forests ranking next to heart rots in the losses caused. In the future, when the overmature, virgin forests have been largely cutover, these parasites, if not controlled, will be far more damaging than fungi (*1*)." Nevertheless, only in the past few years have surveys been made to determine the extent of occurrence.

The case against mistletoe is well summarized in a recent publication by William R. Pierce (*5*). His studies of western Montana

GROWTH-INHIBITING COMPETITION OCCURS IN MOST SEEDLING, SAPLING AND POLE STANDS

These data from an area near St. Regis show the percentage of stands with light and heavy competition.

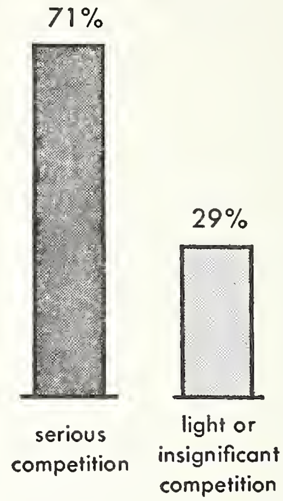


FIG 7

larch and Douglas-fir show that a heavy infection reduces basal area growth of individual trees about 69 percent; a moderate infection reduces it 41 percent; and a light infection 14 percent. Since mistletoe infection reduces height growth as well as diameter growth, it is not surprising that other studies show cubic-foot growth reduced from 41 to 89 percent, depending upon how heavily the stands have been hit (*3*).

STANDS THAT FALL BEHIND NEVER CATCH UP!

This chart compares croptree sizes in medium-site larch stands under three conditions:

① full silviculture
② no silviculture
③ silviculture started at age 50

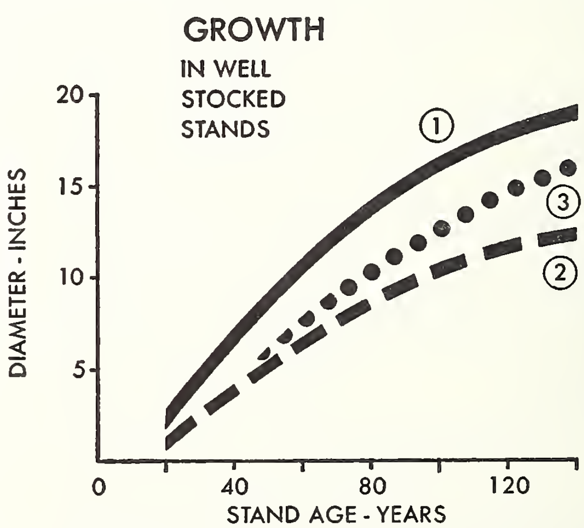


FIG. 8

A survey by Donald P. Graham[6] shows that dwarfmistletoe has a foothold in all parts of the Clark Fork Unit. Figure 9 presents some of the highlights from his survey. One-third of the commercial forest (2.3 million acres) has infected trees, and three-quarters of a million acres are heavily infected. This parasite saps about 40 percent of the timber growth on the land where it occurs. It is probably causing the Clark Fork Unit to lose 70 to 80 million board feet of sawtimber growth annually.

Mistletoe takes on added significance because there is as yet no way to deal effectively with this pest once it has become established in a stand. It is highly desirable, therefore, to find some chemical means for cleaning up existing infections. Until some such mass attack method is developed, mistletoe control procedures will be at cross purposes with other silvicultural practice. The thinning so desperately needed to increase tree growth would in many stands speed the development and spread of mistletoe. Pending a mass control procedure, five facts are important:

- We will have to live with existing infection in older stands until they can be harvested. Some heavily damaged older stands should have a high priority for logging.
- There is a limited opportunity to clean up some of the lightly attacked younger stands by cutting infected trees.
- Where thinning is being considered and mistletoe is present, the advantages of improved growth may have to be weighed against the disadvantages of increasing the mistletoe problem.
- More than one-quarter million acres of pole, seedling, and sapling stands are so heavily infected that they can never produce usable wood in any quantity. Some of these stands are stagnated as well as diseased.
- New stands will have be established in such a way that infection will be held to the minimum.

[6]Dwarfmistletoe survey in western Montana. (In process).

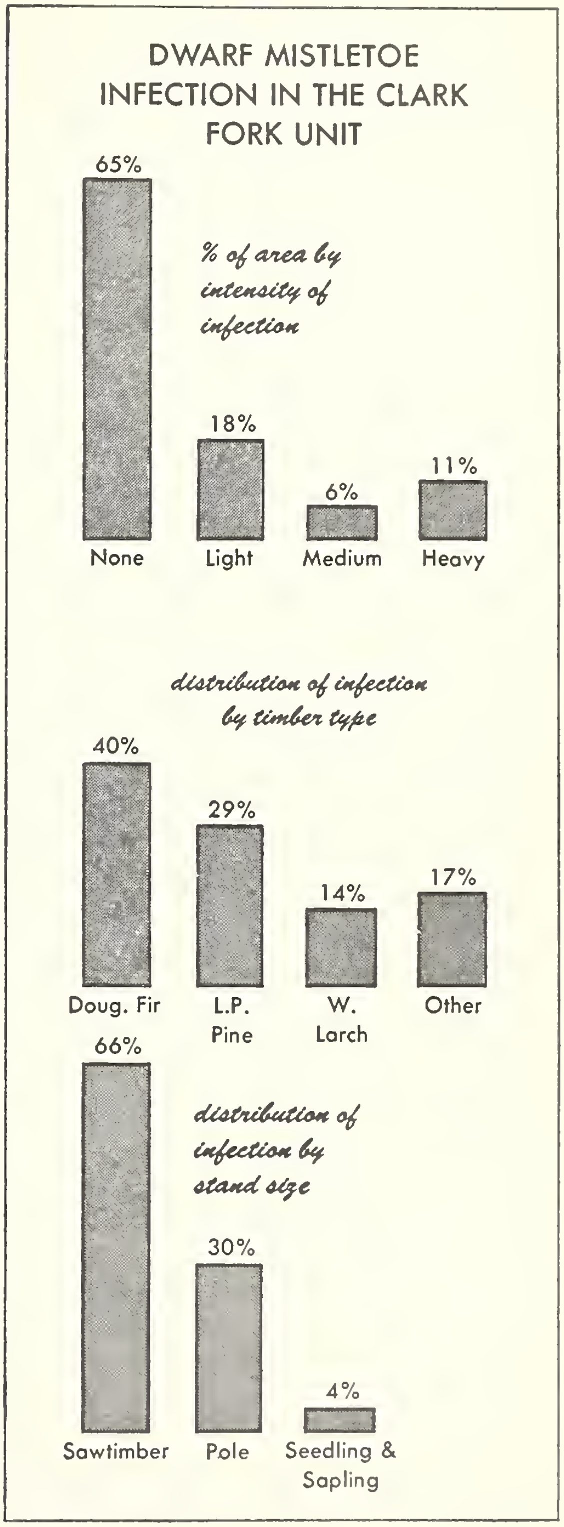


FIG. 9

For many years, mistletoe was virtually ignored. Now that it has been "discovered" it will likely receive a great deal of attention. However, the list of destructive agents is long. Others, including the heart rots, comandra rust, and western gall rust, also damage many trees and must be studied and evaluated before we can completely comprehend the protection problem.

The disorganization of the forest

Timber has been harvested in the Clark Fork Unit for more than a century, but so little cultural work has been done that the forest still retains the general characteristics of a natural forest. That is, it is a jumbled collection of stands. It must be molded into an orderly arrangement of sizes and ages if an even flow of products is to be achieved.

Fortunately, the Clark Fork Unit contains enough mature timber to keep industry supplied for many years while younger stands are being shaped into a managed forest. However, a sizable portion of the volume is in old stands vulnerable to insects and disease and cannot be held for a long period. Past cutting has tended to complicate this problem, for timber has been logged without sufficient regard for its vitality or for the need to maintain an even flow of products by species. Thus, cutting has contributed in its own way to an imbalance in the growing stock.

The problem of unbalanced inventory is most acute in the ponderosa pine type. This is not surprising, as ponderosa pine practically carried the lumber industry for many decades. Today there is little or no cushion or surplus of merchantable timber and the shortages of smaller size trees are particularly striking. Figure 10 compares the average stand per acre in the ponderosa pine type on national forest land with the stand required to sustain the production of this type at 75 percent of yield table levels. There are apparently plenty of 4-, 6-, and 8-inch trees but not enough larger

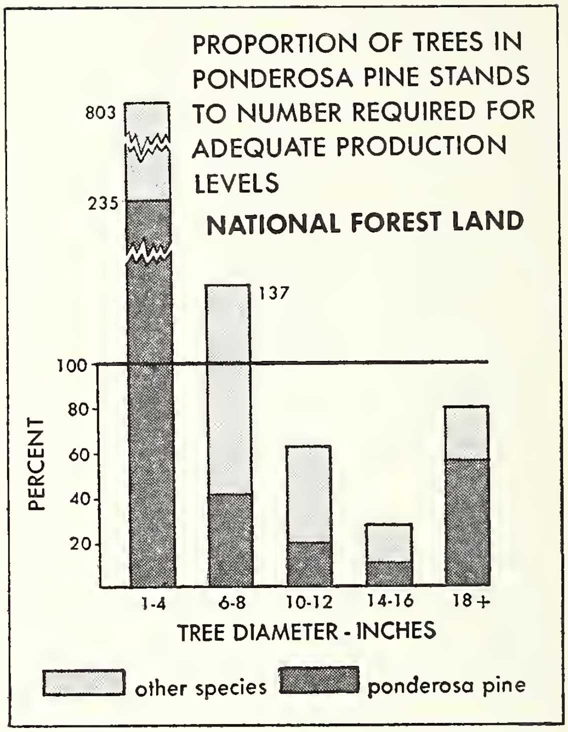


FIG. 10

trees.[7] The amount of ponderosa pine is especially inadequate and the other species that occur in the type make up only part of the deficiency. The size of the management problem is best indicated by the fact that the number of 14- and 16-inch pines should be increased tenfold or more to achieve an even flow of products from this type.

The proportion of ponderosa pine in ponderosa pine stands is higher on private lands than on the national forests. Otherwise, the inventory picture on these lands is about the same as on the national forests.

We pointed out earlier that loggers have made heavy inroads in the ponderosa pine type because of the high value of this species. Prior to World War II, roughly 40 percent of

[7]One difficulty in this comparison is that it does not distinguish between trees that have a place in the future development of the stand and those that are excess. Because of this, the situation is probably even less satisfactory than we have indicated.

the lumber cut in the Clark Fork Unit was ponderosa pine. In the 1950's, the cut of other species rose substantially and ponderosa pine production declined. Today, ponderosa pine is only one-fourth of the total cut. Nevertheless, the 120 million board feet or so of ponderosa pine sawtimber cut from the lands of all owners in 1958 appears to be twice as much as can be sustained by the present growing stock.

Overcutting of ponderosa pine today is a problem, chiefly on private lands. However, the very unsatisfactory tree-size pattern on the national forest (fig. 10) indicates the need to take a serious look at the allowable cut that has been established for these lands also. The cut of ponderosa pine on the national forests may have to be reduced below present levels for some years before it can be increased, in order to build up the growing stock and overcome the serious deficiency of trees 10 inches and larger shown in figure 10.

There are three ways future curtailment of ponderosa pine production can be minimized:

1. Spread out the merchantable reserve of ponderosa pine as far as possible by logging decadent trees first, leaving those sawtimber trees that are growing well.
2. Discourage "premature" cutting of 10-, 12-, and 14-inch trees. These are the fast-growing trees that will help fill the gap 40 to 50 years from now. This will be difficult because much of the young ponderosa pine grows on the lands of so-called "small private owners."
3. Reclaim some of the area that was once ponderosa pine but has since been taken over by other species following logging of the pine. There is a problem of restoration of ponderosa pine on these sites through type conversion. In some of these stands, other species have gotten such a start we may have to raise and harvest them first. However, a good part of the original ponderosa pine area probably should be restored to ponderosa pine because this tree is so much more valuable than the species that are replacing it. This will have to be done largely through planting.

The bright spot in the timber inventory is in the forests of larch, Douglas-fir, and associated species, that occupy slightly more than half of the commercial area. There is not enough young timber in these types but the surplus of older timber both accounts for and offsets this deficiency (fig. 11). The annual cut of larch, Douglas-fir, and spruce is rising; so the problem will be to avoid consuming the surplus too rapidly.

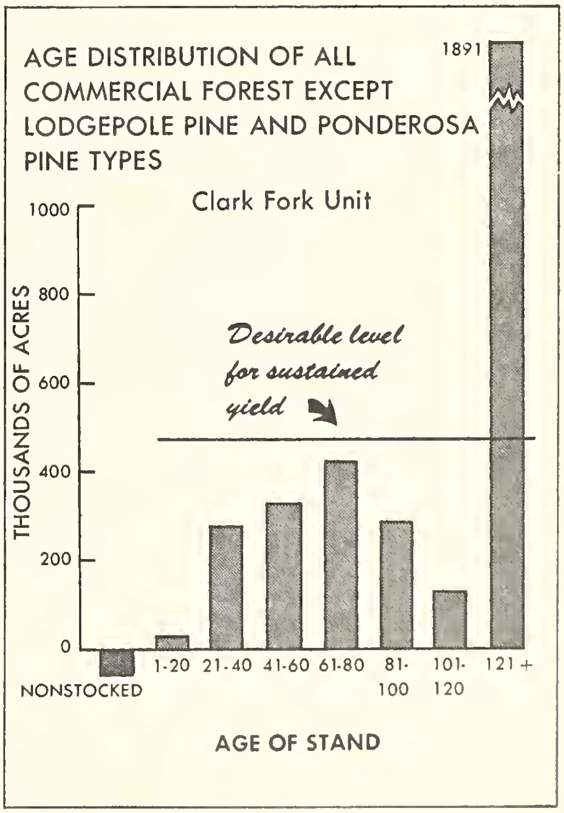


FIG 11

The lodgepole pine type presents a different problem. Superficially, at least, the age pattern is good (fig. 12), but when stand-size is considered, the situation is not so good. At least 9 percent of this type is stagnated. Many other stands 30 years and older have been overcrowded for so long that they are not likely to respond to management and probably never will produce sawtimber-size trees. In planning cultural work in the lodgepole pine type, it will be necessary to look at every young stand and appraise its vigor and potentialities. This will require a more complete understanding of lodgepole pine physiology and silviculture than we now have.

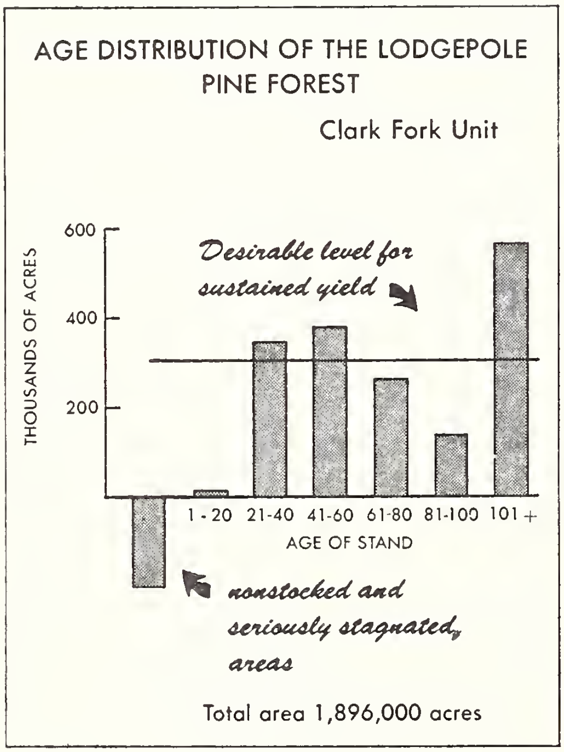


FIG 12

Erosion of quality

THERE HAS BEEN A DECLINE IN THE QUALITY OF TIMBER CUT IN THE CLARK FORK UNIT THAT HAS LARGELY PASSED UNNOTICED. Yet, a look at pictures of logging taken before 1900 suggests that either the horses and men were smaller then or that the logs are not as big as they once were. A few pictures hardly prove a trend; nevertheless, there has been a decrease in average log diameter that no one can actually measure. Whatever the decline has been, it is neither bad nor unreasonable. In the first place, the timber logged first was some of the biggest and best, and it was located in the easily accessible valley bottoms. It will not be possible to duplicate the 200-, 300-, or 500-year-old giants in rotations of 120 or 140 years. Another reason it takes more logs to make a load now than it once did is that the value of wood has increased and logs and trees are consequently being used that formerly were left behind as too small to be handled economically.

Log quality is a compound of size, growth characteristics, and freedom from defects. In this region, log size and frequency of knots are the principal factors foresters have to worry about. Large, high quality logs can be grown in rotations of 120 or 140 years, but they can be grown only by maintaining adequate growing space through thinning. The problem of knots likewise will need special attention if a significant amount of clear wood is to be produced. Wikstrom and Wellner's publication, mentioned earlier, discusses the limbiness problems in detail (*9*). Following, however, is the situation in brief.

Limb persistence is a characteristic of every softwood species in this region. The problem is less severe with larch because larch branches tend to be small, but it still is present. Rapraeger, in a very limited study, found that on one white pine tree, branch scars had not healed over for an average of 72 years after the limbs had died (*6*). On a second white pine tree, the average time for dead limbs to fall and the scars to heal was 93 years. How representative these two trees are is perhaps debatable. Nevertheless, we are perfectly safe in saying that the average period

of dead limb persistence on natural growing stock in the Clark Fork Unit is at least one-half century. How much of a competitive handicap this is may be judged from a study by Benson H. Paul (*4*). He says that in the South, dead limbs persisted on shortleaf pine for an average of 12 years. On loblolly pine, the time span was 8 years, and on slash and longleaf pines, 6 years.

When trees are grown to ages of 200 years or more, there is generally still time to put on clear wood after the dead branches have dropped from the lower bole. However, if the pruning is left to nature, very little clear wood will be grown in the rotations of 120 to 140 years used in public management planning in this area. **PRUNING IS GENERALLY THOUGHT OF AS THE ULTIMATE IN FORESTRY AND SOMETHING OF A LUXURY. HOWEVER, IN THIS REGION, BECAUSE LIMB PERSISTENCE IS SUCH A SERIOUS MATTER, IT CAN BE MORE ACCURATELY DESCRIBED AS BREAD-AND-BUTTER FORESTRY, ALONG WITH THINNING.** There is a need to consider carefully what will happen in this region if both thinning and pruning are not made a part of management.

Since there is more than passing resemblance between the Clark Fork Unit of Montana and northeastern United States we can get an idea of what is at stake from the latter area. The problems of timber growing differ in the two regions in some respects, but it is appropriate to point out what happened to the eastern white pine in the absence of effective forestry. Lumbering in the United States began more than 300 years ago in eastern white pine stands renowned for their tall, clear trees. Yet, today the industry there is plagued with a high proportion of low-quality wood. It is reported that 55 percent of the white pine lumber now being produced in the Northeast is number 4 and 5 common, which means it is barely good enough to use (*8*).

The problem in the Clark Fork Unit likewise will be to keep log quality from drifting steadily downward and to stabilize it at a reasonable level. A big part of that task will be to reduce limbiness through pruning.

Stand regeneration

Some of the oldest forestry thought in this region was related to methods of establishing new stands following logging with emphasis on creating conditions that would facilitate the natural reseeding of the logged areas. With these beginnings, it is not surprising that consciously and unconsciously nature has been assigned the major responsibility for replacing the forest man has logged.

This policy which places dependence primarily upon natural reproduction has paid off well in some instances, for the new stands thus established have the vigor, density, and composition necessary for high yields. More often, however, stands thus established leave much to be desired.

VIEWED FROM THE ANGLE OF BUILDING UP FOREST PRODUCTIVITY TO SUSTAIN A LARGER TIMBER INDUSTRY, A POLICY OF TOO-COMPLETE RELIANCE UPON NATURAL REGENERATION HAS DISADVANTAGES AND DANGERS. In the first place, those young trees left standing after an area has been logged are very often poorer than they appear. Many of the small trees growing in sawtimber stands look young but are actually fairly old in relation to their size. What is more important, they lack the vigor of youth. Retarded trees vary in their capacity to respond to release, but in stand after stand the response is relatively small. New stands planted at the time of logging would, in many instances, pass them by and achieve volume yields not attainable with advance reproduction.

Natural reproduction, either in the form of young trees left after logging or established by natural reseeding following logging, may turn out to be costly for other reasons. One cost is the reduced productivity resulting from both understocking and overstocking of areas

on which a big investment must be made in protection and administration over a rotation. If the decision is to plant after waiting in vain for natural reproduction, the cost of planting may be higher than it would have been if done immediately after logging, because brush has become established in the interim. On the other hand, the overstocking that sometimes results from natural seeding requires extra thinning measures not necessary in stands established artificially.

Dependence upon natural regeneration also reduces the opportunity to select species and to choose superior stock. This matter of species composition and quality of growing stock cannot be passed over lightly if we plan to make the most of the timber growing opportunity. For example, it might be a mistake to accept lodgepole pine on land best suited for spruce merely because a pine seed source is available or to accept slower growing natural stock instead of planting genetically improved trees.

Planting is not, of course, a cure-all. The planter has problems of seed source, survival, planting techniques, and cost. Nevertheless, in many situations natural regeneration will be too haphazard or will produce the wrong kind of stands. The only silvicultural solution to these situations appears to be to plant or seed. Each year about 20,000 acres of national forest and 30,000 acres in other ownerships are cutover. Only about 1,000 acres are planted each year — most of that on the national forests. In other words, nature is being depended upon to restock about 49,000 acres annually. The Forest Service is currently planning to expand its planting program on cutover areas. How far the program should be expanded is a moot point. The question can be answered only after a critical inspection of cutover areas and a detailed analysis of planting opportunities. The brief look at the problem in connection with this study indicates that it may be desirable to plant as much as 40 percent of the area logged each year; that is, about 20,000 acres in all ownerships. In any case, much more logged area needs to be planted if the Clark Fork Unit is to be managed for high production.

FORESTRY PROGRESS WON'T BE CHEAP

ANYONE HOPING THE SAWTIMBER CUT IN THE CLARK FORK UNIT WILL GO UP AND STAY UP IN THE ABSENCE OF A CORRESPONDING RISE IN THE FORESTRY EFFORT WILL BE DISAPPOINTED. Big yields require a substantial outlay of effort and there is already a considerable backlog of work to be done. The longer the delay in tackling this backlog, the harder it is going to be to catch up.

Twenty-twenty hindsight tells us that a big silvicultural opportunity was missed on the area burned during the region's turbulent fire years. During the first quarter of this century alone more than 1 million acres were burned in the Clark Fork Unit. Although these fire losses were regarded as disastrous at the time, there was a silver lining in the plumes of smoke. The fires made way for large areas of new forest in a region overloaded with mature stands. These young stands will play a key part in any future forestry program. Yet, they will not contribute as much to future yields as they might have merely because they were not thinned before they reached 20 to 30 years of age. The stands growing on the 1910 burn are a good example of the timeliness aspect of silviculture. It will cost from 2½ to 3 times more per acre to thin these stands now than it would have earlier.

A search of the record indicates that less than 20,000 acres have been thinned in the unit to date. Not even half that area has been pruned.

THE DELAY IN GETTING STARTED WITH THINNING IS GOING TO CUT INTO FUTURE YIELDS. Many stands have gone into a growth decline due to overcrowding from which they will never completely recover. Cores taken from tree after tree in stands 50 years and older tell the same story: booming growth rates have nosedived to various degrees as the canopy has closed in and competition has become stiffer (fig. 13).

When we look at what happened in the context of the times, it is difficult to see how the course of events could have been much different. Fifty years ago, forestry in the Clark Fork Unit was in a heavy shadow of uncertainty. The timber industry appeared to offer only a limited opportunity. Serious discussions were held as to whether we could afford even to protect some forest land. The outlook today is quite different. Timber production appears a more promising enterprise. While we still lack the data necessary to define the limits of the desirable and justifiable forestry program the area of uncertainty has been considerably reduced.

Just what it will cost to catch up with the silvicultural job in the Clark Fork area is an open question and will remain so until the goals are more clearly defined and better information is available as to the condition and potential of the forest. The best estimate we have of the total present job is based on an examination of Forest Survey plot data. It was possible to identify only certain obvious opportunities for planting, thinning, and pruning from the plot record. Yet, the job totaled to almost $20 a commercial acre, or $126 million in all (table 2).

This must be regarded as a conservative estimate of the total amount of work possible, as available Forest Survey plot data do not really indicate what needs to be done about such problems as dwarfmistletoe; nor do they show the magnitude of the regeneration task on cutover areas.

There is also the question of whether we want to do the total job. Any cost estimates must be tentative until the decision is made as to how much of the commercial forest area

Table 2. — *A minimum estimate of possible forestry measures in the Clark Fork drainage*

Forestry measures	National forests	Other owner-ships	Total
	— *Millions of dollars* —		
Pruning	18	18	36
Planting	19	20	39
Clearing	1	neg.	1
Thinning[1]	34	16	50
Total	72	54	126

[1]The term "thinning" is used here in a broader sense than defined in most textbooks on silviculture. It includes weedings, cleanings, and improvement cuttings as well as cuttings made in older stands to reduce stand competition. Thinning costs in this table are only for precommercial thinning where there are little or no commercial values to defray costs.

is to be devoted to intensified timber growing. Once we have the data needed to establish precise timber growing objectives it may be desirable to exclude the poorer sites from timber production and perhaps some other areas as well. In any case $4 or $5 million could be spent annually for 25 or 30 years catching up with the backlog on the national forests and meeting current silvicultural needs. A somewhat smaller expenditure would be required for catching up on all other lands.

ONCE THIS BACKLOG OF WORK IS COMPLETED, THE TOTAL TIMBER GROWING PROGRAM COULD BE KEPT ROLLING WITH A SMALLER OUTLAY. Here again it is impossible to be specific because timber growing objectives for the national forests have not been precisely defined and data on stand potentialities and treatment costs are very inadequate. However, the planting, precommercial thinning, and pruning program for Clark Fork Unit national forests probably should eventually settle back to something less than $3 million annually.

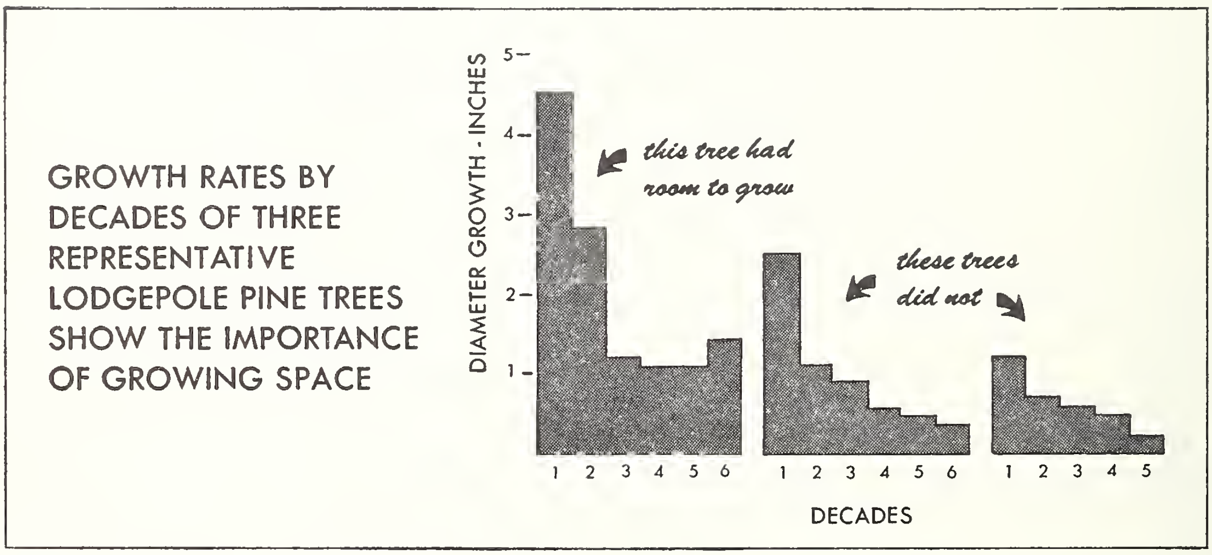


FIG 13

IS IT WORTH IT?

The answer to the above question will depend on who is answering, for the owners in the Unit have all degrees of capacity, purpose, and interests. From that standpoint, they may be divided into three groups: (See also table 3.)

1. Numerous small private owners.
2. A few larger managers such as the Anaconda Company, the Northern Pacific Railroad, the State of Montana, and the Bureau of Indian Affairs.
3. The national forests.

About 400,000 acres of commercial forest in the Clark Fork Unit are in farms and other small holdings. No figures are available to show how many of these small owners there are in this unit, but they probably number at least one thousand. With but few exceptions, the individual holdings of these owners are too small and lack the balance of growing stock required for long-rotation forestry.

The several really large private ownerships (including the semiprivate Indian lands) have the capacity to move into long-rotation forestry and presumably the incentive also. So does the State of Montana, which has been doing a steadily better job of managing its 256,000 acres of commercial forest in the Clark Fork Unit. State operations will be hampered by the fact that much of the State land is scattered and cutover.

Table 3. — *Approximate ownership of the commercial forest*

Ownership	*Million acres*
National forest	3.9
Other "large" ownerships	2.2
"Small" ownerships	0.4
Total	6.5

FORESTRY IN EACH OF THESE OWNERSHIP CLASSES REQUIRES A DIFFERENT TYPE OF EVALUATION. THE REST OF THIS REPORT IS DIRECTED PRIMARILY TO NATIONAL FOREST LANDS, EVEN THOUGH SOME OF THE CONSIDERATIONS APPLY TO THE OTHER TWO OWNERSHIP CLASSES AS WELL, AND SOME OF THE STATISTICS ARE FOR ALL FOREST LAND. Sixty percent of the commercial forest land is in the national forests. This fact, plus the avowed purpose of the Forest Service to maintain a high level of timber productivity and the capacity of the Federal Government to finance long-rotation operations, makes the national forests the best bet for raising timber production in the Clark Fork Unit to a high level.

Board-foot yields can be greatly increased

Natural stands in this region are not in the same class as the spectacular trees and acres in the South and on the West Coast. Nevertheless, well managed stands here can be very productive. For example, on medium sites harvest yields ranging from slightly less than 200 board feet per acre per year to more than 400 board feet are obtainable (*9*). Such production levels compare favorably with most of the forest in the United States.

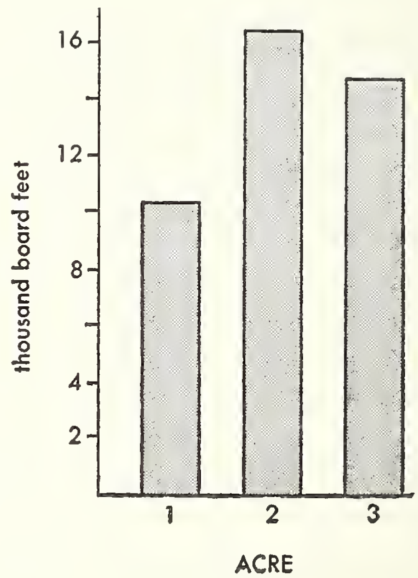
Lodgepole pine is often downgraded as a timber species; yet, as figure 14 shows, this species produces fairly high volume yields when the conditions of stocking are right. The acres described in figure 14 are on good land (that is, medium and better sites). Other lodgepole pine stands on equally productive land grew only matchsticks in the same length of time.

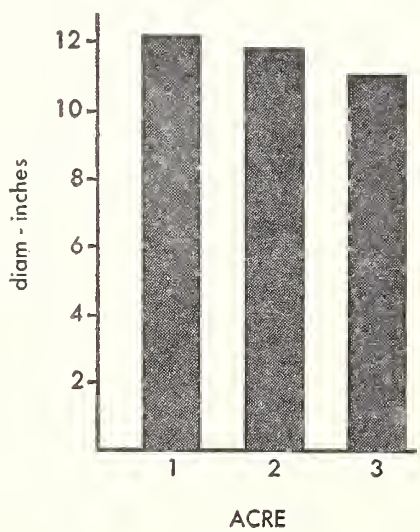
A thinning and pruning study shows that in the lodgepole pine type, for example, thinning in those stands in which it is not too late to thin would do three things:

1. Make it possible for all, instead of half, of the stands to produce sawtimber in 100 to 120 years.
2. Increase the average size of the harvestable trees.

In most Lodgepole Pine stands the trees and volumes are small. However, this situation is partly the result of circumstance. For example, there is an extensive stand in Flatrock Creek in which over-crowding has not been severe. Here the trees have grown well.

HERE ARE DATA FROM THREE TYPICAL ACRES IN THAT STAND WHICH IS 60 - 70 YEARS OLD ON GOOD SITE LAND





BOARD FOOT VOLUME PER ACRE

AVERAGE DIAMETER OF 100 LARGEST TREES PER ACRE

FIG. 14

3. Increase the number of harvestable trees.

The end effect of such gains on medium sites would be to produce a crop of 23,000 board feet per acre in trees 11 inches in diameter and larger. The present average yield of mature lodgepole pine sawtimber stands is 6,000 board feet per acre.

With thinning it will be possible to increase harvest yields even more in other types. For instance, in the spruce type, unmanaged stands of rotation age are yielding about 26,000 board feet per acre on medium sites. Thinning properly timed can boost the average yield to 49,000 board feet, which is much closer to the productive capacity of the soil (fig. 15).

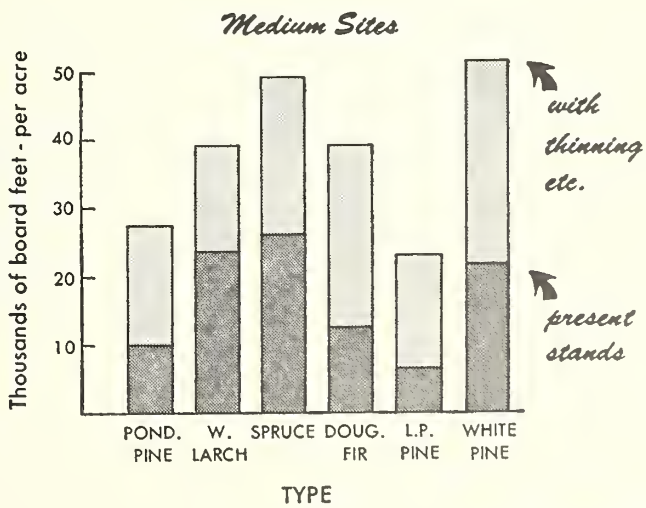
Full benefits from thinning will be realized only in stands fully stocked with vigorous trees. Thus, one step toward higher timber yields is adequate stand reestablishment on deforested and cutover areas. High priority, therefore, should be given to the task of improving the success ratio of stand reestablishment.

The first benefits from thinning are not likely to be spectacular. This is because many existing stands that need thinning have passed the point where they will respond completely to thinning. Nevertheless, some of these stands will have to be opened up to prevent a complete loss of productivity through stagnation and to achieve a partial buildup in yields.

Fast buildup of sustainable cut probably is not possible

There is wood physically available which could be used to expand industry in the Clark Fork. However, because of the imbalance in the growing stock already described, any big expansion now would constitute overcutting and a period of curtailment would inevitably follow. **HOWEVER, IF STAND REGENERATION, THINNING, PRUNING, AND OTHER SILVICULTURAL PROGRAMS WERE BEGUN NOW, A LARGER SAWTIMBER CUT COULD SOON BE JUSTIFIED ON THE NATIONAL FORESTS.** This does not mean that the total sawtimber cut for the Clark Fork Unit should be increased in the near future. Overcutting on other lands probably will offset any gains that can be realized on the national forests.

COMPARISON OF PER-ACRE VOLUMES OF WELL-STOCKED ROTATION-AGE NATURAL STANDS WITH VOLUMES POSSIBLE WITH ADEQUATE STAND REGENERATION AND THINNING



data for Western Montana

FIG. 15

Source: Wikstrom & Wellner

In fairness, we should point out that one of the main problems facing foresters in this region is that they lack a completely reliable basis for computing cutting budgets. The data available do not adequately describe the condition of the growing stock. As a consequence, forest managers have been unable to relate levels of cut to intensity of management. Thus, any estimate of future output is bound to be speculative.

Figure 16 probably represents as good an expression of the management opportunity as can be derived now for the 6.5 million acres of commercial forest of all ownerships in the Clark Fork Unit. The calculations and assumptions behind this chart are presented in Appendix A.

The story told by the chart is essentially this: **BECAUSE THE YIELD CAPABILITY OF THE FOREST DURING THE NEXT FOUR OR FIVE DECADES IS MORE NEARLY DEPENDENT UPON WHAT WAS NOT DONE IN THE PAST FIVE DECADES THAN IT IS UPON WHAT MIGHT BE DONE IN THE COMING YEARS, THERE WILL BE LITTLE CHANCE TO SUSTAIN A HIGHER SAWTIMBER CUT FOR A LONG TIME.**

- The first real upsurge of yields (on a sustained yield basis) cannot come until stands now under 40 years of age begin to move into maturity. Most stands older than that are too old to respond fully to release, but some will have to be thinned to keep them from stagnating. Commercial yields from thinning, likewise, are not likely to play an important part in the total production for several decades although there is probably some opportunity to increase present production by thinning.

POSSIBLE TREND OF SAWTIMBER YIELDS UNDER A FULL MANAGEMENT PROGRAM ON THE 6.5 MILLION ACRES IN THE CLARK FORK UNIT

— ALL OWNERSHIPS —

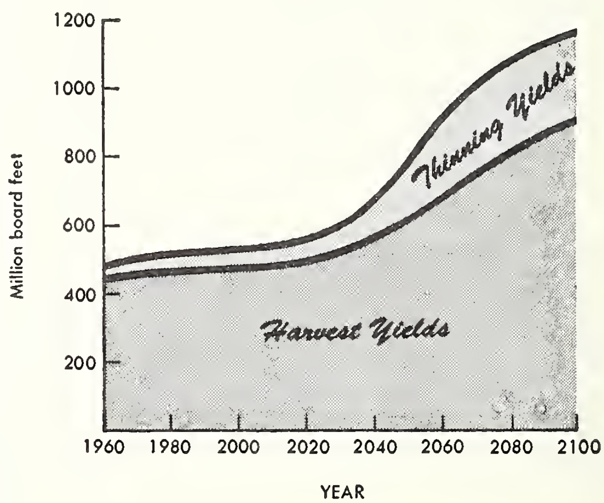


FIG. 16

- The big payoff from present forestry effort will begin in three-quarters of a century. Yields will climb rapidly after that. It is physically feasible to plan on an ultimate annual output of from 1.1 to 1.2 billion board feet.

The prospects for industrial development are not, of course, entirely tied to the sawtimber supply. Even though the sawtimber situation appears to be deteriorating slowly, primarily because the forestry effort is not big enough, there is still a lot of wood available in smaller trees, largely unmarketable in the past.

To the extent that these less-than-sawtimber-size trees can be utilized, the cut could be increased immediately. The recent cut of all trees 5 inches and larger has been about 75 million *cubic feet* per year. If industry could adapt its appetite to using all the pole-size trees in mature stands, the currently sustainable production would appear to be about 25 percent larger than the present total cut.

Unless there is drastic technological change, the surplus of small trees is not and never will be a substitute for sawtimber for the same reason these trees are largely unmarketable today. Big trees are not only cheaper to log and manufacture than small ones; they have the size and quality characteristics for producing more valuable products.

This difference in value shows up in stumpage prices. Ponderosa pine sawtimber is selling for about $15 per thousand board feet. Lodgepole pine trees, which have essentially the same qualities but are mostly smaller than sawtimber size, are selling for only $5 per thousand board feet—where they can be sold.

Wood utilization men make the point that the best hope for using the small timber in this region lies in maintaining a substantial cut of larger trees. The bigger, higher value logs historically have carried a disproportionately large share of the cost of area development and thus have subsidized the less valuable material. Therefore, a national forest management program directed toward producing bigger and better trees should enhance the possibilities of industrial expansion that more completely utilizes smaller trees.

The big effect will be on values

THE ARGUMENT FOR INTENSIVE FORESTRY IN THIS AREA IS LARGELY TUNED TO THE FACT THAT THINNING AND PRUNING IN PROPERLY REGENERATED STANDS WILL PRODUCE REALLY HIGH CROP VALUES. Size increases from thinning alone will boost revenues considerably. For example, the value *per board foot* of 24-inch trees is three times the value of 12-inch trees (fig. 17). Revenue possibilities will increase still more if the stands are both pruned and thinned.

The man with the thinning ax and pruning saw can produce a particularly remarkable improvement in lodgepole pine revenue. The average gross value of merchantable lodgepole pine on the stump today is about $36 per

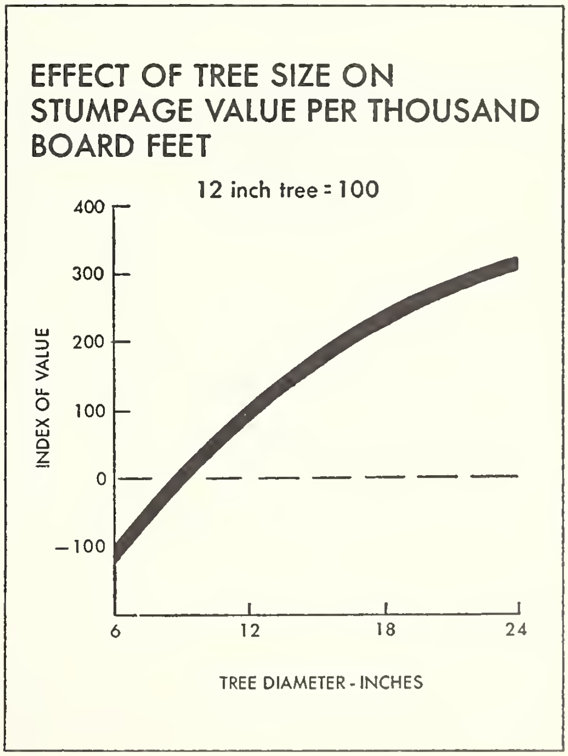


FIG 17

acre on medium sites, which is not much value for 100-plus years of growth. However, lodgepole stands that are thinned as they should be in the coming years will produce timber worth $269 or more per acre (at current prices). Thinning, plus pruning, can raise the crop value to $737, about 20 times the present level (*9*).

Crop values on medium-site western white pine lands carried through a rotation can be lifted from $330 to almost $2,200 an acre. The story is the same in each of the other types. Thinning and pruning can raise gross dollar returns 4 to 20 times higher than they are now (fig. 18).

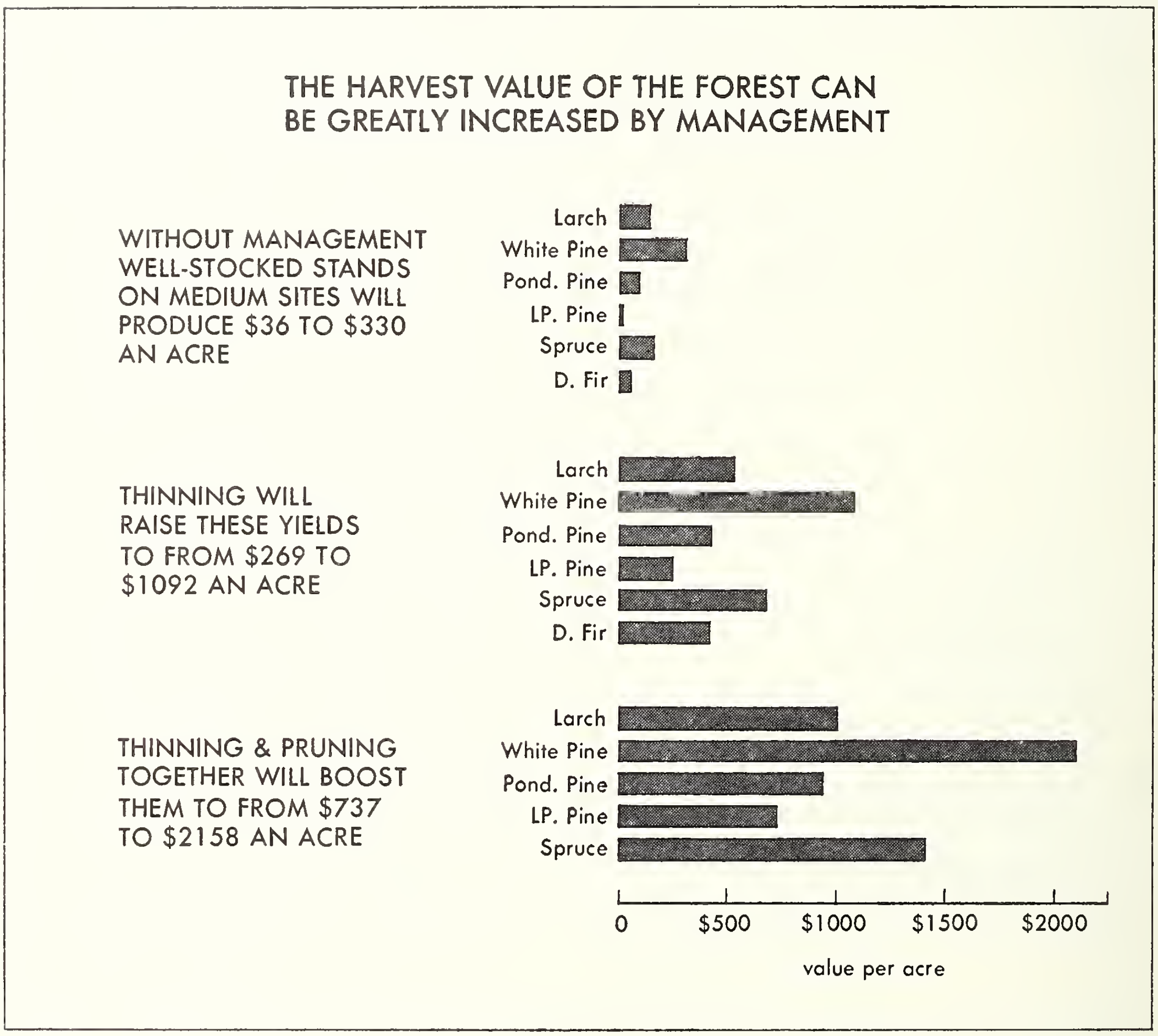


FIG 18

Ultimately values can be high

In timber management, as well as in other phases of national forest administration, there are two basic issues: WHAT needs to be done and HOW MUCH needs to be done to make these areas contribute as they should to the future needs of society? These issues also apply to private lands but they are the overriding consideration on public lands.

Although the **what** question is complex enough, as we have already shown, it is easier to resolve than the **how much** question. Primarily this arises from the fact that while Americans have embraced natural resource conservation with some enthusiasm, economic evaluation processes relating to resource management have not yet fully matured. There are, in fact, some rather substantial differences of opinion about the mechanics of analysis that make it necessary for anyone discussing the subject to state his point of view. Some would limit economic analysis to an acre-by-acre comparison of the capacity of land to produce an interest return on the estimated costs of production. Long-run values (usually based on present prices) are discounted to determine what expenditure of effort for stand regeneration, thinning, and other silvicultural measures could be justified. At the other extreme are those who feel that this type of analysis has three serious weaknesses as a yardstick for establishing public policy:

1. Because it encourages the assumption that the importance of timber to society as a whole is expressed by the capitalized market value of timber products.
2. Because it projects price relationships so far into the future that they lose meaning in a society like ours of rapid technological change and growth.
3. Because it seems more appropriate to consider the costs of maintaining a society as operating costs rather than as investments.

Examined in an investment framework, the earning power of the Clark Fork Unit, and for that matter any of the forests in the Mountain States, is hardly such as to arouse much enthusiasm. Table 4 shows the interest-earning capacity of different parts of the forest under more or less typical assumptions of silvicultural practice.

These calculations include no allowance for the value of the land or costs of controlling insects and diseases but neither do they allow for the historic upward trend of prices.

Table 4. — *Estimated rate of return on regeneration, thinning, and pruning investments by type and site*[1]

Type	Site		
	Good	Medium	Poor
	Compound interest return—percent		
Ponderosa pine	2.2	1.7	1.1
Spruce	2.4	2.2	1.4
Larch	2.4	2.0	1.3
Douglas-fir	2.0	1.7	.9
Lodgepole pine	2.7	2.1	1.2

[1]The costs and values entering these calculations are shown in Appendix B.

Some forest economists who make financial calculations like those in table 4 will say that because other nonmarket considerations are important, it is desirable to undertake a timber growing program even though the interest return is low. We, the authors of this publication, question the desirability of such computations in the first place, because the nonmarket considerations are so overwhelmingly important as to make the traditional investment calculations beside the point on public lands and possibly also on some of the larger private holdings.

We also feel that so long as it appears there will be a need for the timber, it is illogical to encourage the public to continue to pay 50 cents per acre per year to operate the forest of this area for an annual gross revenue of 51

cents plus certain other social economic values, when for 75 cents per acre per year the productivity of the land could eventually be increased to give a gross revenue of $1.39 along with other benefits. The following remarks are from that point of view.

If we focus our attention on the decisions to be made relating to the national forests, three factors seem both relevant and significant:

1. **INTENSIFIED FOREST MANAGEMENT IN THE CLARK FORK NATIONAL FORESTS APPEARS TO BE GOOD BUSINESS.** As we have said, the practice in economic evaluation of forestry generally is to consider each acre separately, calculating what it will cost to grow the stand, and comparing costs to harvest values sometime hence. There is a certain amount of inconsistency in the process, as fire protection is generally regarded as an operating cost and not an investment. Where long rotations are involved, the compounding of interest charges against the costs of the necessary silviculture tends to lead to the conclusion that the effort isn't very much worthwhile.

Although the investment concept of the forestry operation is applicable to certain situations, it is not mandatory that it be applied universally. The objective of society is to devise evaluation procedures to fit its needs rather than to warp its operations to fit the mechanics of an analytical system. The question so far as public forest land administration is concerned is, how much of the money received for stumpage and deposited in the Federal Treasury should be returned to cover stand regeneration and silvicultural work in young stands. In other words, the basic question is whether to consume the timber resource capital or to maintain it consistent with some specified timber growing objective. This question precedes any consideration of investment. That being the case, there appears much logic to considering the total timber-growing property or management unit as a single package. From this "one enterprise" viewpoint the costs on the acres that require silviculture (the young stands) become chargeable to the acres producing revenues (generally the sawtimber stands). When this is done, each year becomes a financial calculation unto itself.

In view of past experiences with the practice of depleting renewable resources, the consequences of not returning enough to the land hardly need to be proved. It is in this sense that intensified public forestry is good business. The situation is parallel to that of the farmer who holds out money for seed, plowing, and taxes from his harvest income, but none for the fertilizer required to maintain soil productivity. If he fails to recognize all of the costs year after year, he is merely easing himself into a marginal existence while enjoying a foolish satisfaction from "profits" that are partly capital depletion. By "plowing back" a substantial part of national forest timber revenues each year, it will be possible to greatly enhance the quantity, quality, and therefore value of future timber yields.[8]

2. **INTENSIFIED TIMBER MANAGEMENT WILL BRIGHTEN THE LONG-RUN PROSPECTS OF LOCAL COMMUNITIES.** The alternatives, so far as local communities are concerned, are worth restating. If efforts in stand regeneration, thinning, and pruning are not intensified, there will be only minimum opportunity to increase the total cut from the national forest. The quality of the timber harvested will decline: That is, the trees will be smaller and limbier. If history means anything, we may be sure the wood industries of the future will adapt to whatever raw material is available. However, it is hard to ignore the probability that the poorer their

[8]There is little direct relation between revenues and subsequent expenditures in actual practice. Except for certain permitted withholdings, the revenues are divided between the Federal Treasury and local governments. Congress determines and appropriates operating funds. Nevertheless, any evaluation of business opportunity requires some such comparison of costs and returns.

raw material the less the wood industries will contribute to local income.

If silvicultural practice is intensified to some degree, we may expect a corresponding increase in the value and potential contribution of the forest. The significance of this to community expectations for security and growth needs no explanation. As a matter of fact, if the governmental responsibility for economic continuity and economic opportunity is taken seriously, some degree of intensification of silvicultural practice is synonymous with sound administration of the national forests in the Clark Fork Unit.

3. **INTENSIFIED TIMBER MANAGEMENT HERE CAN SERVE NATIONAL INTERESTS AS WELL.** There are two aspects to this situation: The relation of the Clark Fork Unit timber to the Nation's total wood needs; and the relation of timber growing on these national forests to efficient multiple-use operation.

The U. S. Forest Service report, Timber Resources for America's Future (*7*), examined the long-run forestry outlook in this country and concluded that all of the forest area and forestry effort likely to be mobilized would undoubtedly be required to assure adequate timber supplies in the future. This establishes a good reference point for an aggressive public forestry program. However, even if one does not take these long-range prognostications seriously, a strong rationale can be developed for such a program. We must admit that the future is as much of an uncertainty as it ever was and that there is no good basis for predicting the political, technological, and resource context that our timber supply situation will be set in during years to come. However, this uncertainty is a two-way street in that the dangers of underestimating future needs are just as great as the dangers of overestimating. That being the case, it becomes a matter of national prudence to practice a "productive" level of management on public forest land. Prudent management requires no great sacrifices in a rich nation like this that has more manpower than it is able to use effectively. As Robert L. Heilbroner says in his book, The Making of Economic Society, "A society with unemployed factors can put its idle resources to work building capital without diminishing its expenditure on consumption" (*2*).

The Clark Fork Unit is an important headwater of the Columbia River system. It provides outstanding hunting, fishing, and other recreational attractions. Thus, the national forests here will have to be protected and administered regardless of the industrial wood they produce. Timber growing will, however, increase the efficiency of the whole national forest operation. Figure 19 illustrates the advantage to be gained. The data in this chart are only illustrative and have no more stature than any other calculations related to values so far in the future. Both the costs and returns may turn out to be quite different than have been assumed. The point they make is nonetheless valid. It is that once the productivity of the timber stands is built up by silvicultural effort (which will be many years hence) it would be appropriate to expect timber revenues at that time to make the national forests financially very productive, not only defraying the total cost of protection and management but returning a good surplus besides. A sizable expenditure for silviculture will be required for many years before that happy situation is achieved.

Facing into the future

In forestry, more than almost any other enterprise, looking ahead and developing clear-cut objectives are essential forerunners of purposeful action. If we can agree that silvicultural effort beyond what has been done in the past is desirable in those areas to be dedicated to timber growing, the first step is to decide which areas these are. Productivity of some of the poorer land is undoubtedly too low to justify intensive cultural programs. Other very steep or fragile areas probably

AN ILLUSTRATION OF THE ALTERNATIVES:

EVENTUAL ANNUAL COSTS AND SAWTIMBER RETURNS FROM THE CLARK FORK UNIT NATIONAL FORESTS WITH A MINIMUM PROGRAM DESIGNED PRIMARILY TO PROTECT WATERSHEDS AND SUSTAIN A LOW LEVEL OF SAWTIMBER YIELD.

Basic costs of administration and protection	$1,950,000
Minimal expenditure for management sufficient to insure regeneration of all areas	1,000,000
Total expenditures	$2,950,000
Value of 300 million board feet annual cut	3,000,000
Net	+$50,000

EVENTUAL ANNUAL COSTS AND SAWTIMBER RETURNS FROM THE CLARK FORK UNIT NATIONAL FORESTS WITH A FULL PROGRAM OF STAND REGENERATION, THINNING AND PRUNING.

Basic costs of administration	$1,950,000
Costs of stand regeneration, thinning, pruning, etc.	2,920,000
Total expenditures	$4,870,000
Value of 600 million board feet annual cut	$9,000,000
Net	+$4,130,000

FIG. 19

should be withdrawn from commercial timber production simply to protect watersheds. During the coming few decades it probably will be necessary to concentrate efforts on the most productive lands. In any case, priorities of action need to be established. National forest administrators in this region are working with the Intermountain Forest and Range Experiment Station to develop new and better data for describing action needs.

Clarification of objectives is only part of the administrator's problem. At present he is handicapped by the lack of answers to important silvicultural questions. The two major timber questions he is asking the researcher today are: How can we do a better job of reestablishing spruce and Douglas-fir stands? and, What are the potentialities of tens of thousands of half-grown stands if we treat them in different ways?

* * * *

The national forests of the Clark Fork Unit are but a small part of the total public forest in the United States. Moreover, since they are operated with appropriated funds, the financial needs for public forestry must be weighed against the needs of other items in the public sector of our economy. Allocation of public funds involves considerations beyond the scope of this discussion. It is sufficient to say here, perhaps, that these public holdings that have been capably protected and managed in the past offer a substantial additional opportunity in the form of intensified silviculture.

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APPENDIX A

The information on potential yield summarized in figure 16 is based on cutting over an equal portion of the area during each year of the rotation wherever possible. Potential harvest yields for the first few decades were estimated by multiplying the average volume per acre in current sawtimber stands by the area to be harvested. Subsequent harvest yields were developed from a projection of existing stands and stands to be established under an assumed level of management which included a complete thinning program.

Table 5 shows the trend in harvest cut we estimate is possible with management in the Clark Fork Unit. Except in the lodgepole type, there is little likelihood that harvest cuts can be increased until the youngest of the present stands reach maturity. From then on, the cut could be increased so as to reach the potential for the assumed level of management by the end of the rotation.

The lodgepole pine yields presented in table 5 are predicated on dropping utilization standards from the present 11.0 inches d.b.h to 9.0 inches and later to 7.0 inches.

Table 5. — *Trend of harvest cut possible with management in the Clark Fork area*

Rotation year	Annual Yield			
	Ponderosa pine type	Lodgepole pine type	Other types	Total
	— — — — *Million board feet* — — — —			
1	91	100	260	451
21	91	120	260	471
61	91	137	260	488
81	91	182	260	533
86	110	182	260	552
98	168	182	260	610
101	168	182	368	718
108	212	182	368	762
121	212	182	387	781
141	212	305	387	904

Eventually, sizable intermediate yields from commercial thinnings can be expected in the Clark Fork Unit. However, to begin with, these yields will be small because there are so few stands in which commercial thinnings can be justified. Once the young stands now being treated precommercially attain sawtimber size, the amount of wood available in intermediate yields will increase. Table 6 shows the trend in harvest cut and the trend in yield from thinnings we estimate to be possible in the Clark Fork area.

Table 6. — *Trend of harvest cut plus thinning cut possible in the Clark Fork Unit with management*

Rotation year	Annual Yield				
	Harvest	Thinning			Total
		Ponderosa pine type	Lodgepole pine type	Other types	
	— — — — *Million board feet* — — — —				
1	451	—	—	34	485
21	471	—	—	34	505
51	471	8	—	34	513
61	488	8	8	34	538
71	488	17	8	61	574
81	533	17	29	61	640
86	552	17	29	61	659
91	552	37	29	61	679
98	610	37	29	61	737
101	718	37	50	135	940
108	762	37	50	135	984
111	762	46	50	135	993
116	762	46	50	159	1,017
121	781	46	53	159	1,039
141	904	46	53	159	1,162

It is possibly too much to assume that there will be a full scale thinning program during the first rotation. However, this optimistic assumption is tempered somewhat by conservative yield estimates in tables 5 and 6.

Basic information on yield estimates

Ponderosa pine type. — In order to estimate the ponderosa pine situation, a tabulation was developed from Forest Survey data comparing the area actually occupied by each age-class of timber with a theoretical stand table for the type. Table 7 converts the all-age ponderosa pine stands to an area unit basis for the purpose of estimating the area theoretically occupied by each age-class.

Table 7. — *Area units and acres theoretically occupied by each ponderosa pine age-class in the Clark Fork Unit by owner class and all owners*

Age class (years)	National forest		Other owners		All owners
	Area units	Acres	Area units	Acres	Acres
0 - 9	50.80	159,948	52.44	270,553	430,501
10 - 17	9.62	30,289	18.47	95,292	125,581
18 - 24	12.79	40,270	13.02	67,174	107,444
25 - 33	7.79	24,527	10.63	54,843	79,370
34 - 43	7.41	23,331	8.20	42,306	65,637
44 - 55	5.83	18,356	6.45	33,277	51,633
56 - 74	6.16	19,395	5.88	30,337	49,732
75 -100	5.28	16,625	4.89	25,229	41,854
101 -129	5.68	17,884	3.89	20,070	37,954
130+	28.64	90,175	16.13	83,219	173,394
Total	140.00	440,800	140.00	722,300	1,163,100

The critical point in the above tabulation is in the 56- to 74-year age-class. Thus, in a sustained-yield program, these and older stands should be utilized over an 85-year period. Following that, $\frac{1}{\text{Rotation}}$ of the area should be cut annually.

Table 8 shows the effective area to be cut over and the volume available by periods. Since the forest has been converted to equivalents of ideally stocked areas, the volume per acre used to estimate total volume yield is that which we estimate is possible under management (25,600 board feet).

Because the ponderosa pine type is generally understocked, the sawtimber volume obtainable from intermediate cuts will be insignificant until the fifth decade from now. Stands thinned at 60 to 70 years should produce a second thinning at 90 to 100 years. The higher site areas are expected to produce a third thinning at about 110 years of age.

Table 8. — *Trend in harvest cut possible in the ponderosa pine type in the Clark Fork Unit by area cut over and volume attainable*

Years	Effective area cut over each year	Annual timber cut
	Acres	*M bd. ft.*
1- 85	3,564	91,238
86- 97	4,303	110,157
98-107	6,564	168,038
108-116	8,300	212,480
117-123	8,300	212,480
124-131	8,300	212,480
132-140	8,300	212,480

Thinning yields shown in table 6 are based on thinning 8,300 acres each year in each thinning treatment and on the assumption that:

- The first commercial thinning will yield 1,000 board feet per acre beginning in the sixth decade from now.
- In 70 years the thinning yields will rise to 2,000 board feet per acre.
- In 90 years a second thinning will be possible yielding 2.5 thousand board feet per acre in addition to the 2,000 board feet above.
- In 110 years a third thinning will be possible on medium and better sites, raising the average yield from intermediate cuts by 1,000 board feet per acre. (8,300 × 2M + 8,300 × 2.5M + 8,300 × 1M = 45.7 million board feet, table 6.)

Lodgepole pine type.—About the only opportunity for increasing allowable cut in the lodgepole pine type in the next 50 years will come through increased cutting of smaller trees. As far as sawtimber is concerned, this merely means that a higher level of sawtimber cut will be achieved in this period only by lowering the standard of what is called sawtimber. This has already been occurring. The harvest cuts shown in table 5 are based on cutting over 15,200 acres per year. It is assumed that during the first two decades:

- Trees 9.0 inches d.b.h. and larger will be utilized.

- The average volume per acre cut will be 6,600 board feet.

During the third, fourth, and fifth decades:

- Utilization standards will drop to include half of the trees 7.0 inches to 9.0 inches in diameter.
- The average volume per acre cut will increase to 8,300 board feet.

Beginning with the sixth decade:

- All trees 7.0 inches and larger will be utilized.
- The average volume per acre cut will increase to 9,100 board feet.

Beginning with the eighth decade:

- Harvest yields should begin to reflect the impact of management and should average 12,000 board feet per acre.

By the end of the rotation:

- Harvest yields should be up to 20,000 board feet per acre.

There is little chance that intermediate cuts for sawtimber can be made in the lodgepole pine type during the next 50 years. Most of the less than rotation-age stands that are now sawtimber size lack the vigor necessary to make thinning worthwhile. Most likely, intermediate sawtimber yields in this type will not amount to much until stands now treatable precommercially have attained sawtimber size.

The intermediate yields shown in table 6 for lodgepole pine are based on the following assumptions:

- An intermediate cut averaging 1,000 board feet per acre over 15,200 acres will be possible beginning with the sixth decade from now.
- The intermediate cut per acre should increase to 1,500 board feet in the seventh decade.
- By the eighth decade, the intermediate cut per acre should be 2,500 board feet.
- In 90 to 95 years a second commercial thinning will be possible on the medium and better sites, raising the average yield per acre in intermediate cuts to 3,500 board feet for the 15,200 acres, although actually more acres than that will be thinned annually.

Other types

The data on trends in harvest yields in types other than ponderosa pine and lodgepole are based on cutting over the area in 140 years, or 24,450 acres annually. It is further assumed that:

- It will be impossible to materially increase per acre yields above the current level of 10,000 board feet during the next 80 years.
- After 80 years the effect of management should begin to be reflected in increased per acre yields, which should climb to 15,000 board feet.
- In 120 years the cut per acre should be up to 24,500 board feet per acre.

There are about 1.2 million acres of young stands in which thinning could be done. The intermediate yields shown in table 6 are based on the assumption that this area will be thinned commercially during the next 70 years and will yield 2,000 board feet per acre in intermediate yields. After 70 years, stands established following 1960 will begin to yield intermediate cuts. It is assumed that these stands will:

- Be thinned at age 70 at the rate of 24,500 acres per year, yielding 2,500 board feet per acre.
- At age 100 a second thinning will be made yielding 3,000 board feet per acre on another 24,500 acres.
- At age 115 to 120 a third thinning will be possible on the medium and better sites which will increase the average yield from intermediate cuts the equivalent of another 1,000 board feet per acre for 24,500 acres. ($24,500 \times 2.5M + 24,500 \times 3M + 24,500 \times 1M = 159.3$ million board feet, table 6.)

APPENDIX B

SOME STATISTICS DESCRIBING THE CLARK FORK AREA AND FOREST RESOURCE

Table 9. — *Area in the Clark Fork Unit by major land classes*

Land class	Area-acres
Water area	122,317
Forest Land	7,646,662
Commercial	6,482,112
Noncommercial	1,164,550
Nonforest Land	2,636,863
All Land	10,283,525
Gross Area	10,405,842

Table 10. — *Commercial forest area by type and ownership class, Clark Fork Unit*

Type	Area by owners		
	Total	National forest	Other owners
	Acres		
Douglas-fir	2,168,028	1,173,183	994,845
Lodgepole pine	1,895,840	1,440,315	455,525
Ponderosa pine	1,163,086	440,813	722,273
Western larch	722,069	453,090	268,979
Engelmann spruce	300,168	231,299	68,869
Alpine fir	68,517	58,515	10,002
Whitebark-limber pine	54,123	31,125	22,998
White pine	49,507	49,438	69
Hardwood	28,166	1,650	26,516
Grand fir	11,308	10,892	416
Western redcedar	9,813	6,011	3,802
Mountain hemlock	6,303	6,303	....
Western hemlock	5,184	3,125	2,059
All types	6,482,112	3,905,759	2,576,353

Table 11. — *Commercial forest area by stand-size and two owner classes, Clark Fork Unit*

Stand-size class	Area by owners		
	Total	National forest	Other owners
	Acres		
Sawtimber	3,707,279	1,986,257	1,721,022
Pole	2,091,574	1,423,207	668,367
Seedling-sapling	584,536	425,841	158,695
Deforested	98,723	70,454	28,269
Total	6,482,112	3,905,759	2,576,353

Table 12. — *Estimated rate of return on regeneration, thinnng, and pruning investments by type and site on the Clark Fork Unit*

Species	Site	Treatment age		Treatment cost per acre			Crop value	Rotation	Rate of return
		Thin	Prune	Regen-erate	Thin	Prune			
		Year	Year	Dollars				Years	Percent
Ponderosa pine	G	10	20	60	20	30	1,984	140	2.2
	M	10	30	60	20	33	963	140	1.7
	P	20	40	60	20	42	456	140	1.1
Spruce	G	10	30	40	20	38	2,151	140	2.4
	M	20	30	40	20	35	1,426	140	2.2
	P	20	40	40	20	50	605	140	1.4
Larch	G	10	20	20	20	43	1,698	140	2.4
	M	10	30	20	20	53	1,011	140	2.0
	P	20	—	20	20	—	218	140	1.3
Douglas-fir	G	10	—	30	20	—	715	140	2.0
	M	20	—	30	20	—	446	140	1.7
	P	20	—	30	20	—	160	140	.9
Lodgepole pine	G	10	20	15	20	52	1,434	120	2.7
	M	10	30	15	20	55	737	120	2.1
	P	20	—	15	20	—	124	120	1.2

The Intermountain Forest and Range Experiment Station, U. S. Forest Service, has headquarters in Ogden, Utah, and field offices at:

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